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RAPID VARIATIONS IN EARTH'S SATELLITE DRAG AND PROPERTIES OF THE UPPER ATMOSPHERE

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SUMMARY

This note describes the correlation analysis of rapid variations of atmosphere density in the 165 – 215 km altitude range, determined by the fluctuations of the variation rates of anomalous periods of 11 American satellites tracked by radar.

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The satellites were observed in the period of solar activity minimum, in 1963 and 1964. The precision of density determination is very high; the interval of data smoothing constituted a few hours, the table spacing constituted 0.1 day, the total number of density estimates being ∿360. It was shown in [1] that strong fluctuations in the Earth's atmosphere density take place even in periods of relatively moderate geomagnetic activity, and certain statistical estimates are brought out; however, statistical methods were not broadly applied.

An auto and cross-correlational method of analysis is presented in the current work. The values x of density, determined by satellite deceleration served as the initial material, alongside with the 3-hour geomagnetic index a_p – y, obtained from [2, 3]. The computed values of the autocorrelational and cross-correlational functions $r_\tau(xx)$, $r_\tau(yy)$, $r_\tau(xy)$ are represented by crosses in Figs 1 – 3. The theoretical auto-correlational and cross-correlational functions $\rho_\tau(xx)$, $\rho_\tau(yy)$, $\rho_\tau(xy)$ are also represented in the same figures for the simplest model:

$$\frac{d}{dt}x(t) + \lambda[x(t) - \langle x \rangle] = f(t), \qquad \langle f \rangle = 0, \tag{1}$$

$$r_\tau(ff) = \exp[-\Lambda|\tau|], \tag{2}$$

$$y(t) = af(t - \Delta) + \phi(t), \qquad \frac{\langle y^2 \rangle}{a^2 \langle f^2 \rangle} = \epsilon. \tag{3}$$

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The empirical and theoretical correlational functions agree for the values:

$$\Lambda = 16 \text{ days}^{-1}, \quad \lambda = 8 \text{ days}^{-1}, \quad \varepsilon = 2, \quad \Delta = 0.15 \text{ day} \qquad (4)$$

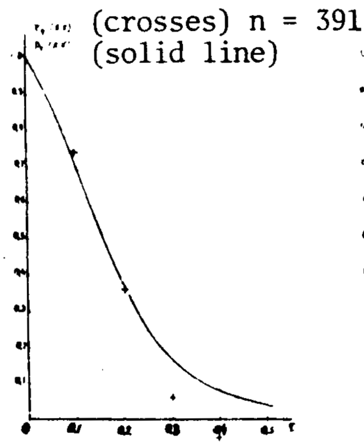

Fig.1

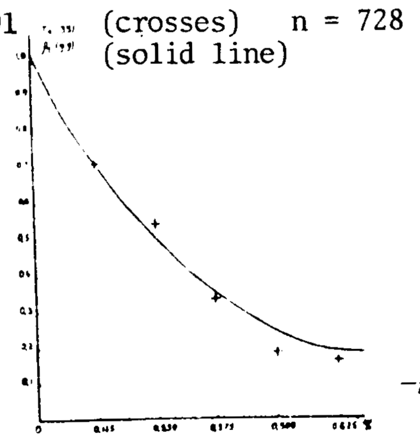

Fig.2

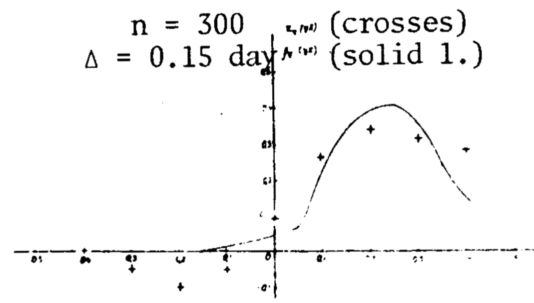

Fig.3

Eq.(1) is the heat transfer equation of the thin layer, f is proportional to the variable heat flow, λ is proportional to the temperature conductance of the layer [4, 5] at the altitude where energy absorption takes place, linked with corpuscular streams. Eq.(2) is the simplest equation describing the link between the variable heat flow and the planetary geomagnetic index, Δ is the lag time on account of finite heat conductivity ($\Delta = 1/\lambda$).

Utilizing the standard atmosphere model [6] and the estimate (4), we obtain the value of the effective absorption height of the variable heat flow linked with geomagnetic disturbances:

$$z = 170 - 210 \text{ km}.$$

This effective height is substantially greater than the height of ultraviolet's absorption, which is $z = 110 - 120$ km [4, 5] and the actions upon the upper atmosphere of the variable ultraviolet and corpuscular radiations are divided in space by altitude.

These results have a preliminary character; they underscore the necessity of detailed study of rapid (hourly) variations of upper atmosphere density.

*** T H E   E N D ***

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REFERENCES

1. R. L. JACOBS. LMSC Tracking Note No.69, 1965
2. BARTELS..... [the rest of references is missing, the reprint being incomplete]